

# Real-time gated-SPECT myocardial perfusion imaging with CZT detectors: A promising tool for monitoring left ventricular function

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The use of stress single-photon emission computed tomography (SPECT) cardiac imaging for the assessment of myocardial perfusion has become one of the most used noninvasive approaches for the management of patients with known or suspected coronary artery disease (CAD).<sup>1</sup> The possibility to perform gated-SPECT as a routine part of clinical protocols offers the advantage to add to perfusion data functional parameters, such as left ventricular (LV) volumes, ejection fraction (EF), and regional wall motion, increasing the diagnostic accuracy and clinical utility of cardiac SPECT imaging.<sup>2,3</sup> The assessment of LV volumes and EF represents a powerful and reliable method for the prediction of long-term prognosis and for clinical decision making in patients with heart diseases.<sup>4,5</sup> There are many automated algorithms for quantification of SPECT parameters of myocardial perfusion and LV function, which have demonstrated accuracy and reproducibility.<sup>6</sup> For the assessment of LV volumes and function, cardiac magnetic resonance (CMR) is considered the reference standard noninvasive method for validation of other imaging techniques. It is due to the characteristics of CMR imaging, a method that does not depend on geometric assumptions of LV shape.<sup>7</sup> This approach is characterized by high reproducibility, excellent temporal and spatial resolution, and low interobserver and intraobserver variability.<sup>8</sup> A good agreement of LV

functional parameters between gated-SPECT by conventional Anger camera and CMR imaging has been demonstrated both at rest and post-stress. However, it has also been shown that gated-SPECT LV volumes and functional parameters may be underestimated by using standard cameras compared to CMR, showing high variability.<sup>9,10</sup> Probably, the underestimation of end-diastolic and end-systolic volumes may be mainly explained by the limited SPECT temporal and spatial resolution. Other factors that may contribute to the discrepancies between these two modalities include the use of different algorithms and the possibility that in patients with large perfusion defects, severe reduction or absence of photon counts in a myocardial region may lead to an underestimation of regional wall motion, due to inadequate visualization.<sup>11</sup> Using conventional Anger camera with waiting periods after stress tracer injection of at least 15 minutes, but sometimes also up to 60 minutes, post-stress LV function and volumes may be underestimated and early ischemic functional changes after stress test might be not identifiable. In addition, acquisition time with conventional cameras is very long and this may lead to a resolution of the LV function during this long time. All these characteristics do not allow to identifying post-stress LV function and wall motion abnormalities, which have been demonstrated to be correlated with severe obstructive CAD.<sup>12</sup>

The introduction of new dedicated cardiac cameras based on cadmium-zinc-telluride (CZT) semiconductor technology, characterized by a higher photon sensitivity and higher temporal and spatial resolution than standard systems, could overcome most of the limitations of conventional Anger cameras. The use of CZT camera technology enables a significant reduction in both radiation exposure and acquisition time without loss of image quality.<sup>13</sup> Previous studies have demonstrated excellent agreement between CZT SPECT and CMR imaging for the measurement of LVEF, although significant differences were found in the measurement of

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ventricular volumes.<sup>14</sup> For the determination of LVEF and regional wall motion estimation, 16-frame reformatted images appear to be more accurate than 8-frame images.<sup>15</sup>

In the current issue of the *Journal*, Nkoulou et al<sup>16</sup> evaluated the feasibility of LVEF measurements and its accuracy to detect clinically relevant changes in systolic function during standard dobutamine stress protocol assessed by real-time high-speed gated-SPECT using CMR as standard of reference. The study was conducted in 50 patients referred for SPECT MPI using a hybrid CZT/CT device. All SPECT images were acquired at rest after injection of 320 MBq of <sup>99m</sup>Tc-tetrofosmin twice consecutively over 3 minutes each and after dobutamine stress test. In particular, stress SPECT was performed during low-dose dobutamine and at peak stress during maximum dobutamine dose. Finally, gated post-stress images were acquired after 5 minutes of injection of 960 MBq of <sup>99m</sup>Tc-tetrofosmin. In this way, the authors performed real-time LV function assessment, in addition to assess perfusion images at rest and at high-dose stress. Moreover, in 20 patients an additional rest/dobutamine CMR was performed within two weeks from SPECT imaging. The authors found an excellent agreement between CMR and gated-SPECT for rest LVEF, end-diastolic, and end-systolic volumes. At peak stress, gated-SPECT identified 14 of 16 patients with a change in LVEF  $\geq 5\%$ , and 3 of 4 patients with stable or decreasing LVEF by stress CMR with an agreement rate of 85%. On the contrary, LVEF derived from post-stress SPECT, reflecting standard SPECT acquisition with conventional camera, showed only a modest agreement (45%), allowing identifying 8 of 16 patients with increasing LVEF, and 1 of 4 with stable or decreasing LVEF by stress CMR. The results of this study highlight the opportunity to obtain highly repeatable LV function measurements by using new CZT camera with short acquisition time, allowing clinical follow-up of patients. Moreover, the protocol proposed by Nkoulou et al<sup>16</sup> might represent a valid method in patients with multivessel disease, allowing evaluation of regional stress-induced contractile dysfunction. CZT SPECT technology improves sensitivity and spatial resolution compared to conventional gamma cameras. This new technology allows obtaining fast imaging with high myocardial count rate, which lead to a good image quality and improved diagnostic accuracy. In addition, owing to the possibility to perform the procedure in a very short acquisition time, there is low rate of motion artifact with high patient throughput.<sup>17</sup> A CZT system also allows performing several acquisitions as dynamic imaging or dual isotope acquisition. Recently, Brodov et al<sup>18</sup> demonstrated the feasibility of measuring LVEF reserve by short, successive acquisitions, starting 5

minutes after regadenoson injection by using a novel high-efficiency SPECT camera with solid state cardiac-focused detectors. The authors found a negative, early LVEF reserve among ischemic patients, compared to a positive LVEF reserve among nonischemic patients.<sup>18</sup>

Other imaging modalities are available for evaluation of LV function in patients with CAD. Echocardiography is the most commonly imaging modality used by cardiologists for evaluating ventricular function.<sup>19</sup> It is characterized by short procedure time, low cost, and availability. Moreover, it is noninvasive and radiation free; however, this test technique shows significant variability, because it is subjective and experience-dependent, and in some cases, the acoustic window is limited.<sup>20</sup> Several studies have compared LVEF values obtained from echocardiography and gated-SPECT, reporting variable results. Particularly some studies reported no significant differences between values obtained with SPECT and those obtained with echocardiography.<sup>21</sup> On the contrary, other studies reported higher values of LVEF measured with SPECT as compared to echocardiography.<sup>22</sup> One of the strengths of the work proposed by Nkoulou et al<sup>16</sup> is the use of CMR imaging as standard reference. CMR is characterized by a high reproducibility with low variability, but also higher cost that limits the larger availability. The use of cardiac nuclear imaging with CZT SPECT technology has lead to a reduced dose of radiation for the patient, making these methods very feasible. As also acknowledged by the authors,<sup>16</sup> one of the most important drawbacks of the proposed protocol is the limitation for the assessment of transient ischemic dilatation. This parameter reflects a combination of LV dilation and diffused subendocardial ischemia and provides incremental diagnostic and prognostic information to standard perfusion analysis in patients with known or suspected CAD.<sup>23,24</sup> Although obtained in a limited number of patients, the results reported by Nkoulou et al<sup>16</sup> are very interesting and open the way for wider applications of SPECT imaging. Additional and larger studies are clearly needed to assess the clinical applicability of the proposed approach.

## Disclosure

*M. Petretta and A. Cuocolo declare that they have no conflict of interest.*

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